

CLAIMS

1. A measuring method for optical transfer function, comprising:

a scanning step of irradiating irradiating-light from a light source and allowing the irradiating-light to scan an element to be measured, wherein the element to be measured is an element within an image sensor of an imaging camera constituted by integrating an imaging optical system and the image sensor;

a photoelectric conversion step of converting sequentially the irradiating-light into an electrical signal by the element to be measured along with scanning of the element in the scanning step and then outputting the electrical signal; and

a calculation step of calculating an optical transfer function based on the electrical signals outputted in the photoelectric conversion step, wherein the optical transfer function is used to perform a restoration for degradation of an image generated by use of the imaging camera by a deconvolution processing.

2. The measuring method for optical transfer function according to claim 1, wherein in the calculation step, the optical transfer function of the elements to be measured is calculated based on the spread function data which is generated with scanning by the irradiating-light in the scanning step and which indicates a distribution of the electrical signal

obtained by performing conversion in the elements to be measured.

3. The measuring method for optical transfer function according to claim 2, wherein:

in the scanning step, the irradiating-light producing a point-like projection image on an imaging area is irradiated under a conjugation condition such that the diameter of a paraxial image of the irradiating-light on the imaging area is equal to or smaller than half a pitch of the element; and

in the calculation step, the optical transfer function is calculated based on the point spread function data which is generated as the spread function data.

4. The measuring method for optical transfer function according to claim 2, wherein:

in the scanning step, the irradiating-light producing a linear projection image on an imaging area is irradiated under a conjugation condition such that the width of a paraxial image of the irradiating-light on the imaging area is equal to or smaller than half a pitch of the element; and

in the calculation step, the optical transfer function is calculated based on the line spread function data which is generated as the spread function data.

5. The measuring method for optical transfer function according to any one of claims 1 to 4, wherein:

in the scanning step, the irradiating-light scans a plurality of the elements to be measured; and

the calculation step comprises a processing of performing an interpolation by using the optical transfer functions of a plurality of the elements to be measured and thereby calculating an optical transfer function of an element other than the elements to be measured.

6. The measuring method for optical transfer function according to any one of claims 2 to 5, further comprising a distortion characteristic data generation step generating distortion characteristic data relating to image distortion on the imaging area by using the spread function data and position information of the element to be measured corresponding to the spread function data.

7. The measuring method for optical transfer function according to claim 1, wherein the scanning step comprises a step of changing at least one of irradiating angle and irradiating position of the irradiating-light in the imaging camera so that the irradiating-light scans the element to be measured.

8. The measuring method for optical transfer function according to claim 1, wherein the scanning step comprises a step of changing at least one of angle and position of the

imaging camera so that the irradiating-light scans the element to be measured.

9. An image restoring method, comprising:
  - measuring an optical transfer function by a measuring method according to any one of claims 1 to 8; and
  - applying a restoration processing to image data obtained by the imaging camera by use of the measured optical transfer function.

10. A portable telephone apparatus, comprising:
  - an imaging camera capturing an image of an object and generating image data;
  - storage means for storing an optical transfer function;
  - and,
  - transmission means for transmitting as a set of data the optical transfer function stored in the storage means and the image data generated by the imaging camera;
  - wherein the optical transfer function is measured by a measuring method comprising:
    - a scanning step of irradiating irradiating-light from a light source, and allowing the irradiating-light to scan an element to be measured within an image sensor of the imaging camera, wherein the image sensor of the imaging camera is integrated with an imaging optical system;
    - a photoelectric conversion step of converting sequentially the irradiating-light performing scanning in the

scanning step into an electrical signal by the element to be measured and then outputting the electrical signal; and

a calculation step of calculating the optical transfer function based on the electrical signals outputted in the photoelectric conversion step, wherein the optical transfer function is used to perform a restoration for degradation of an image generated by the imaging camera by a deconvolution processing.

11. A digital imaging device, comprising:

an imaging camera capturing an image of an object and generating image data;

storage means for storing an optical transfer function; and,

transmission means for transmitting as a set of data the optical transfer function stored in the storage means and the image data generated by the imaging camera;

wherein the optical transfer function is measured by a measuring method comprising:

a scanning step of irradiating irradiating-light from a light source, and allowing the irradiating-light to scan an element to be measured within an image sensor of the imaging camera, wherein the image sensor of the imaging camera is integrated with an imaging optical system;

a photoelectric conversion step of converting sequentially the irradiating-light performing scanning in the

scanning step into an electrical signal by the element to be measured and then outputting the electrical signal; and

a calculation step of calculating the optical transfer function based on the electrical signals outputted in the photoelectric conversion step, wherein the optical transfer function is used to perform a restoration for degradation of an image generated by the imaging camera by a deconvolution processing.

12. A portable telephone apparatus, comprising:

an imaging camera capturing an image of an object and generating image data;

tag generation means for attaching to the image data generated by the imaging camera a file number of a data file containing an optical transfer function measured by a measuring method comprising:

a scanning step of irradiating irradiating-light from a light source, and allowing the irradiating-light to scan an element to be measured within an image sensor of the imaging camera, wherein the image sensor of the imaging camera is integrated with an imaging optical system;

a photoelectric conversion step of converting sequentially the irradiating-light scanning the element in the scanning step into an electrical signal by the element to be measured and then outputting the electrical signal; and

a calculation step of calculating an optical transfer function based on the electrical signal outputted in the

photoelectric conversion step, wherein the optical transfer function is used to perform a restoration for degradation of an image generated by the imaging camera by a deconvolution processing.

13. A digital imaging device, comprising:

an imaging camera capturing an image of an object and generating image data;

tag generation means for attaching to the image data generated by the imaging camera a file number of a data file containing an optical transfer function measured by a measuring method comprising:

a scanning step of irradiating irradiating-light from a light source, and allowing the irradiating-light to scan an element to be measured within an image sensor of the imaging camera, wherein the image sensor of the imaging camera is integrated with an imaging optical system;

a photoelectric conversion step of converting sequentially the irradiating-light scanning the element in the scanning step into an electrical signal by the element to be measured and then outputting the electrical signal; and

a calculation step of calculating an optical transfer function based on the electrical signal outputted in the photoelectric conversion step, wherein the optical transfer function is used to perform a restoration for degradation of an image generated by the imaging camera by a deconvolution processing.

14. An image correction method, comprising the steps of:  
    associating an image generated by causing a digital  
    imaging device to perform image-capturing of an object with  
    degradation factor information for correcting the image  
    degraded due to imaging means of the digital imaging device,  
    and outputting the associated information from the digital  
    imaging device; and  
    causing an image correction server apparatus to apply  
    a deconvolution processing to the image outputted from the  
    digital imaging device by use of the degradation factor  
    information associated with the image.

15. A digital imaging device, comprising:  
    imaging means for capturing and generating an image of  
    an object;  
    degradation factor information storage means for storing  
    degradation factor information for correcting the image  
    degraded due to the imaging means; and  
    output means for outputting the degradation factor  
    information associated with the image.

16. The digital imaging device according to claim 15, further  
    comprising receiving means for receiving a corrected image  
    obtained by correcting the image using the degradation factor  
    information outputted from the output means.

17. The digital imaging device according to claim 15 or 16, wherein the degradation factor information storage means stores as the degradation factor information an optical transfer function used in a deconvolution processing.

18. The digital imaging device according to any one of claims 15 to 17, wherein the output means is transmission means for transmitting the degradation factor information associated with the image.

19. The digital imaging device according to any one of claims 15 to 17, wherein the output means is writing means for writing the degradation factor information associated with the image into a recording medium associated with the image.

20. An image correction server apparatus, comprising:  
receiving means for receiving from a digital imaging device an image generated by causing the digital imaging device to perform image-capturing of an object and degradation factor information for correcting the image degraded due to imaging means of the digital imaging device;

image correction means for applying a deconvolution processing to the image using the degradation factor information; and

transmission means for transmitting a corrected image obtained by performing the deconvolution processing.

21. The image correction server apparatus according to claim 20, wherein:

the receiving means receives transmission destination information specifying a transmission destination of the corrected image together with the image and the degradation factor information;

the transmission means transmits the corrected image to a transmission destination specified by the transmission destination information.

22. An image correction system comprising a digital imaging device and an image correction server apparatus, wherein:

the digital imaging device comprises imaging means for capturing and generating an image of an object, specifying means for specifying a transmission destination of a corrected image, and transmission means for transmitting destination information associated with the image generated by the imaging means to the image correction server apparatus, wherein the transmission destination information indicates the transmission destination specified by use of the specifying means and transmitting the associated information; and

the image correction server apparatus comprises image correction means for applying a deconvolution processing to the image outputted from the digital imaging device to obtain the corrected image and transmission means for transmitting the corrected image obtained by use of the image correction means to a transmission destination indicated by the

transmission destination information associated with the image.

23. A program for allowing a computer to execute an image correction method, comprising:

a step of accepting input of a data file containing an image generated by causing a digital imaging device to perform image-capturing of an object and degradation factor information for correcting the image degraded due to imaging means of the digital imaging device; and

an image correction step of applying a deconvolution processing to the image contained in the data file outputted from the digital imaging device by using the degradation factor information contained in the data file with the image.